High Throughput Solvent-free Manufacturing of Battery Electrodes

Project ID: bat558

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Overview

Timeline

- *Project Start Date:* June 2020
- *Project End Date:* December 2023
- ~55% Complete

Budget

- Funding provided by DOE AMO
- *Total Project Funding:* $5.5M
- *DOE AMO Share:* 80%
- *Contractor Share:* 20%

Partners

- Cabot Corporation
- Arkema, Inc.
- University of Tennessee, Knoxville
- Oak Ridge National Laboratory

Barriers

- Traditional binder for solvent-free electrodes (PTFE) is incompatible with solvent-free anodes
- Non-conductive fibrillization promoters are typically needed
- Low mechanical properties for solvent-free electrodes

Impact/Relevance

Impact

- Scalable production of lower-cost, large-format EV-batteries and enabling next generation EV batteries based on-prelithiated anodes or solid-state electrolytes.

Relevance

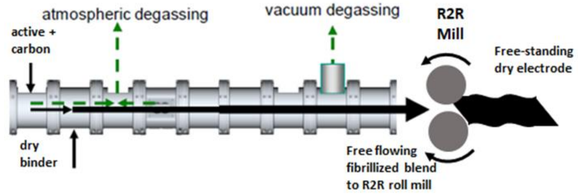
- New advanced dry electrode process (ADEP) improves efficiency and enables next-generation battery chemistries.
- ADEP is seen as a drop-in replacement for conventional slurry mixing, coating, and drying equipment and thereby reducing overall cost by 60%

Target

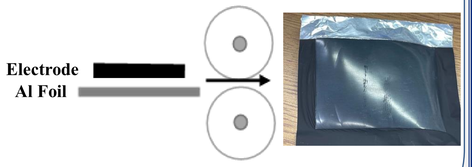
- **Reduce PTFE content to less than 15% initial capacity loss (ICL) while maintaining high mechanical properties**

Approach

- ADEP has been used to increase throughput and degree of PTFE binder fibrillization and provided superior control over range of viscosity, shear energy, and electrode mechanical properties. ADEP can be performed under inert or vacuum conditions at temperature >300°C
- Reduce/eliminate PTFE with advanced binder system and reduce processing additives to reach <15% ICL
- Leverage partners' shared knowledge to gain deeper understanding into fibrillization mechanisms and conduct advanced characterization of developed electrodes



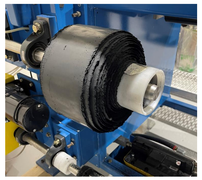
Schematic of ADEP for Solvent-Free Free-Standing Electrode Production



Sheet or Roll-to-Roll Lamination of Free-Standing Electrode to Current Collector

Solvent-Free Electrode Fabrication

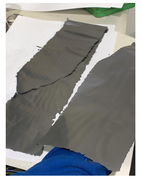
Flakes from Advanced Dry-Electrode Process



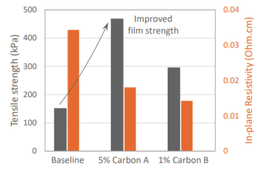
Produce Roll-to-Roll Free-Standing Electrode

Laminate Electrode to Current Collector

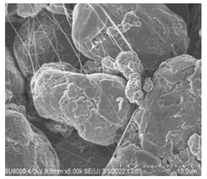
New Solvent-Free Electrode Process Technology



Solvent-Free Anodes from ADEP



New Multifunctional Carbon for Fibrillization

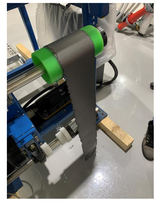


Reduction of PTFE Content While Maintaining Fibrillization

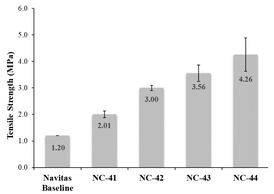
Cell Production

Coin Cells for Material/Process Screening

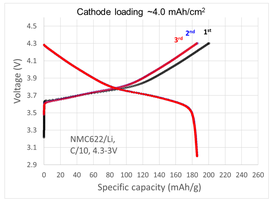
Double Layer Pouch (DLP) Cell for Evaluation



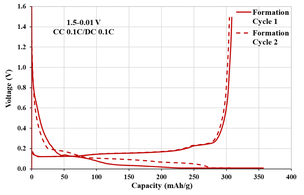
Roll-to-Roll Anode Production



Improved Tensile Strength of Cathodes from Process Modifications



Formation Data of NMC Solvent-Free Cathodes



Formation Data of Graphite Solvent-Free Anodes

Future Work and Proposed Scale-Up

- Increase active material loading to 95-96% for anodes and cathodes within the next year
- Validate process demonstrating EV format prototype cell incorporating solvent-free electrodes attaining 250 Wh/kg and 1000 cycles.
- Retrofit solvent-free electrodes into the current electrode manufacturing at Navitas